

6-8: Using Precipitation and Vegetation to Study Climate Zones

Lesson Plan

Purpose: Scientists are interested in learning how the vegetation (collection of plants) of an area can be used to study Earth's climate. In this lesson, students observe average values of global precipitation and vegetation over the course of one month using NASA visualizations created from satellite data. Students investigate possible relationships between the vegetation and precipitation.

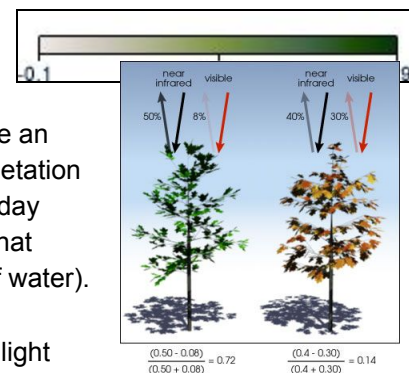
<p>Grade Level: 6-8 Time: 1-60 minute class MND Lesson #52</p>	<p>Lesson Objectives:</p> <ul style="list-style-type: none"> The students observe and analyze monthly global precipitation and vegetation values from 2012. The students make inferences about the role that geographic position has in the distribution of precipitation and vegetation at a global scale. The students analyze locations (of their choice) for possible patterns and relationships between precipitation and vegetation. 	<p>Sphere(s):</p> <ul style="list-style-type: none"> Atmosphere Hydrosphere Biosphere
<p>Phenomena NASA Connection:</p> <p>Scientists are interested in learning how the vegetation of an area can be used to study Earth's climate. Climates can be broadly classified using seasonal and yearly atmospheric conditions which in turn affect global distributions of vegetation and soils. NASA scientists use data from multiple satellites to analyze the relationship of precipitation with vegetation. In this My NASA Data Lesson, Using Precipitation and Vegetation to Study Climate Zones, students observe different visualizations to identify patterns precipitation and vegetation data as they change over time and space.</p>		
<p>Essential Questions:</p> <ol style="list-style-type: none"> In what ways is the Biosphere connected to the Hydrosphere? How does the Geosphere affect global patterns of precipitation and vegetation? What factors affect the amount of precipitation that a region has? How does precipitation change over time? 		
<p>NGSS Performance Expectation(s):</p> <ul style="list-style-type: none"> MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. 		
<p>Science & Engineering Practices:</p> <p>Analyzing and Interpreting Data: Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationship.</p> <p>Developing and Using Models: Develop a model using an example to describe a scientific principle.</p> <p>Obtaining, Evaluating, and</p>	<p>Disciplinary Core Ideas:</p> <p>ESS2.C The Roles of Water in Earth's Surface Processes: The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.</p> <p>ESS2.D Weather and Climate: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude,</p>	<p>Crosscutting Concepts:</p> <p>Stability and Change Stability might be disturbed either by sudden events or gradual changes that accumulate over time.</p> <p>Cause and Effect Cause and effect relationships may be used to predict phenomena in</p>



Communicating Information: Obtain and combine information from books and other reliable media to explain phenomena.	and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. ESS3.D Global Climate Change: Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	natural or designed systems. Systems and System Models Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
NCTM Math Standards: n/a		
Cross-Curricular Connections: National Geography Standards: -How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.		
Career Connections: <ul style="list-style-type: none">o Soil and Plant Scientists – Analyze biological samples, classify organisms based on their characteristics or behavior, conduct research of processes in natural or industrial ecosystems, and research crop management methods.o Atmospheric and Space Scientists – Investigate weather and climate related phenomena to prepare weather and climate related phenomena to prepare weather reports and forecasts for the publico Environmental Planners – Analyze and minimize impacts associated with development projects in urban and regional environments.o Cartographers and Photogrammetrists – Collect, analyze, and interpret geographic data in creation of maps		
Multimedia Resources: <ul style="list-style-type: none">• n/a		
Materials/Resources Needed: <u>Per Student:</u> <ul style="list-style-type: none">• Using Precipitation and Vegetation to Study Climate Zones Datasheet <u>Per Group:</u> <ul style="list-style-type: none">• Copy of Student Pages:<ul style="list-style-type: none">o Monthly Precipitationo Monthly Normalized Difference Vegetation Index	Key Vocabulary: <ul style="list-style-type: none">• Vegetation• Precipitation• Indicator• Climate• NDVI• Claim• Evidence• Reason	
Background Information: Earth's surface is a complex and dynamic set of interconnected systems – principally, the Geosphere, Hydrosphere, Atmosphere, and Biosphere. All of the Earth's processes are the result of energy flowing and matter cycling within and among these systems. Humans and all living things belong to the Biosphere system and although we often take the rest of the biosphere, like plants and trees, around us for granted, almost every aspect of our lives depends upon them. They feed us, clothe us, absorb carbon dioxide, provide us with oxygen, and give us building materials and medications. When drastic changes occur to the vegetation around us, our health, economy, and environment are all affected.		

Satellite maps of vegetation show the density of plant growth over the entire globe. The most common measurement is called the Normalized Difference Vegetation Index (NDVI). Very low values of NDVI (0.1 and below) correspond to barren areas of rock, sand, or snow. Moderate values represent shrub and grassland (0.2 to 0.3), while high values indicate temperate and tropical rainforests (0.6 to 0.8).

In an effort to monitor major fluctuations in vegetation and understand how they affect the environment, 40 years ago Earth scientists began using satellite remote sensors to measure and map the density of green vegetation over the Earth. Using NOAA's Advanced Very High Resolution Radiometer (AVHRR), scientists have been collecting images of our planet's surface. By carefully measuring the wavelengths and intensity of visible and near-infrared light reflected by the land surface back up into space, scientists use an algorithm called a "Vegetation Index" to quantify the concentrations of green leaf vegetation around the globe. Then by combining the daily Vegetation Indices into 8-, 16-, or 30-day composites, scientists create detailed maps of the Earth's green vegetation density that identify where plants are thriving and where they are under stress (i.e., due to lack of water).



Vegetation appears very different at visible and near-infrared wavelengths. In visible light (top), vegetated areas are very dark, almost black, while desert regions (like the Sahara) are light. At near-infrared wavelengths, the vegetation is brighter and deserts are about the same. By comparing visible and infrared light, scientists measure the relative amount of vegetation. (The variation in shade is more apparent in the detail of the U.S. West Coast).

NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. The numbers on the figure above are representative of actual values, but real vegetation is much more varied.

Prerequisite Student Knowledge:

- Seasonal changes related to weather
- Names of continents
- Latitude/Longitude
- Basic ability to read a map

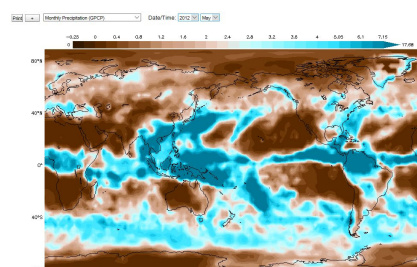
Possible Misconceptions:

- "The intensity of sunlight at a place does not change from day to day during the year (AAAS Project 2061, n.d.)."
- "Thermal energy cannot be transferred between air and water (AAAS Project 2061, n.d.)."

-Taken from AAAS Science Links

Procedure:

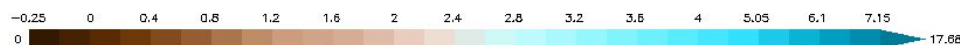
1. Engage prior knowledge by reviewing the concepts of weather vs climate to students (2 minutes)
2. Scientists are interested in learning how the vegetation of an area can be used to study Earth's climate. Today we are going to make observations about the collection of plants (vegetation) in a region and precipitation as climate indicators.





3. Tell students that they are going to observe Monthly images collected by a NASA satellite and share the Monthly Precipitation (GPCP) image first with the class.
4. Distribute the Student Datasheet. Review the key topics below for **Part 1: Observe Precipitation & Vegetation Visualizations**, while also following along with Teacher Key of Student Datasheet.

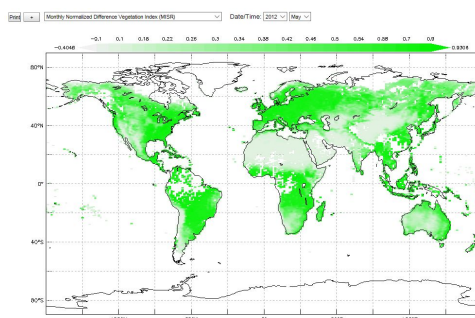
- a. Review the legend of this image. These values are in (mm/day).



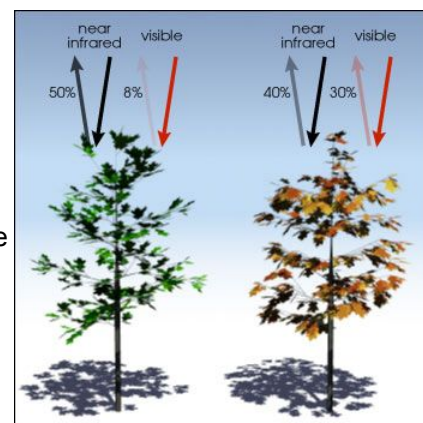
- b. What does the dark brown (or white on grey scale) represent? *Drier conditions*
- c. What does the dark blue (black on grey scale) represent? *More precipitation*

- d. What month does this represent? *May 2012*
- e. Look at the Pacific Ocean. Notice the unique pattern of a streak of precipitation in a zone of dryness. Why is that? *That is where the equator is. This is where we find a lot of rainforests because of the convection cells around earth from the level of radiation from the Sun.*

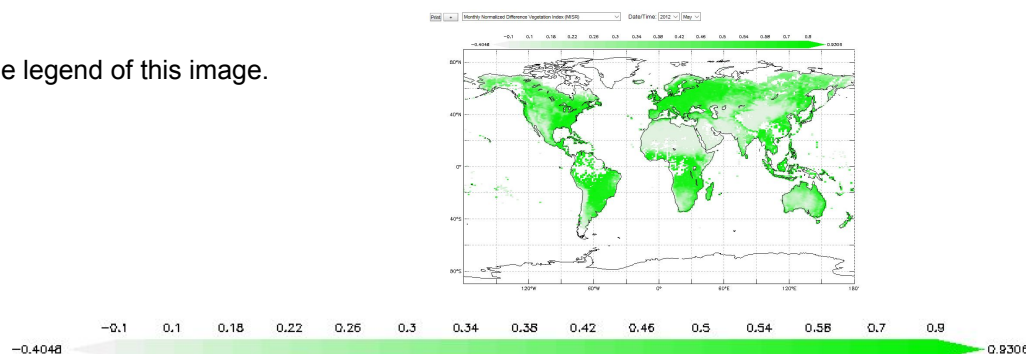
- f. What are climate conditions we might expect in May? *Accept a broad spectrum of answers but emphasis how it depends on where you are on Earth.*



5. Healthy and dense vegetation absorbs most visible light from the Sun, and reflects near-infrared light. Unhealthy or little vegetation reflects more visible light from the Sun and less near-infrared light. Because of this, satellites can measure the amount of reflected visible and near-infrared light to determine the amount of plants on the surface of the Earth. Normalized Difference Vegetation Index, or NDVI, is measured from both types of light. Scientists use the word "index" to mean a measurement of something, so NDVI is a measurement of plants based on the difference between two types of light.
6. Now review the 'Monthly Normalized Difference Vegetation Index' (taken from May 2012). Describe that scientists use the Multi Angle Imaging SpectroRadiometer (MISR) on the Terra satellite to record the type of light, ultraviolet and infrared, reflected from the foliage of the various plants on Earth. Scientists then mathematically process the data, and the result is known as the Normalized Difference Vegetation Index, or NDVI. Explain to students that this image represents the NDVI; it is a measure of how much plant life is on the surface of the Earth. It is averaged over the month.



7. Review the legend of this image.



8. What does the bright green (or black on grayscale) represent? *High values (0.6-0.9) indicate temperate and dense tropical forests.*



9. What does the white (light gray on grayscale) represent? *Low values of NDVI (0-0.1) indicate barren or snow-covered land. Middle values (0.2-0.5) indicate shrubs and grasslands.*
10. What month does this represent? *May 2012*
11. What are the global patterns that these images usually show? Around the equator? Between the poles and the equator?
 - a. *The equator has high temperatures and precipitations year round so have vegetation levels throughout the year.*
 - b. *Between the poles and equator there are rises and falls of vegetation greenness with seasonal changes.*

Part 2: Compare visualizations

5. Now compare the two images and critique these.
 - a. What is one **similarity** and one **difference** between how the data look?
 - *Similarity: They have a higher concentration points in the same area*
 - *Differences: It is limited to just the continents.*
2. Locate an area that has much precipitation but little vegetation.
 - a. *Qualitative Observations:*
 - b. *Quantitative Observations:*
3. Find an area where little precipitation has occurred, yet there is still vegetation
 - a. *Qualitative Observations:*
 - b. *Quantitative Observations:*

Part 3: Investigate Relationships & Patterns

- A. Students investigate an area that has high level of precipitation.
 - a. What is the vegetation level?
 - b. What is the latitude/longitude?
 - c. What is the NDVI value?
 - d. How may these areas be related?
 - i. What additional datasets would you like to review or would be a good match to compare with NDVI?
- B. Students investigate an area that has low level of precipitation.
 - a. What is the level of vegetation?
 - b. What is the latitude/longitude?
 - c. What is the NDVI value?
 - d. How may these areas be related?
 - e. What additional datasets would you like to review or would be a good match to compare with NDVI?
- C. State a claim based on evidence.
 - a. The claim that when _____, then _____ (happens).
- D. Bring the class together to share what they found.



Name: _____

Date: _____

TEACHER KEY

Using Precipitation and Vegetation to Study Climate Zones Student Datasheet

Part 1: Observe Precipitation & Vegetation Visualizations

1. What is the difference between **Climate** and **Weather**? The difference between weather and climate is a measure of time. Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere "behaves" over relatively long periods of time.
2. What are the two science variables you are reviewing today?
 - a. Precipitation
 - b. Vegetation
3. 1st map visualization: Observe Precipitation & Vegetation Visualizations
 - a. What is the name of the map visualization? Monthly Precipitation (GPCP)
 - b. Review the legend of the image:
 - What does the dark brown (or white on grayscale) represent?
Drier conditions
 - What does the dark blue (or black on grayscale) represent?
More precipitation
 - c. What month and year does this visualization show? *May 2012*
 - d. Look at the Pacific Ocean. Notice the unique pattern of a streak of precipitation in a zone of dryness. Why is that?
That is where the equator is. This is where we find a lot of rainforests because of the convection cells around earth from the level of radiation from the Sun.
 - e. Find two locations where there is high precipitation values but little vegetation and where there is little precipitation but high vegetation.
 - i. *ANSWERS MAY VARY.*
 - ii. *ANSWERS MAY VARY.*
4. 2nd map visualization:
 - a. What is the name of the map visualization? Monthly Normalized Difference Vegetation Index
 - b. Review the legend of the image:
 - i. What does the bright green (or dark gray on grayscale) represent? *High values (0.6–0.9) indicate temperate and dense tropical forests.*
 - ii. What does the white (light gray on grayscale) represent? *Low values of NDVI (0–0.1) indicate barren or snow-covered land. Middle values (0.2–0.5) indicate shrubs and grasslands.*
 - iii. What month/year does this represent? *May 2012*



Part 2: Compare visualizations

5. Compare the two visualizations and critique these.
 - c. Describe one similarity: *ANSWERS MAY VARY. Both datasets have a higher concentration points in the same areas.*
 - d. Describe one difference: *ANSWERS MAY VARY. Only the continents share the higher concentration areas.*
 - e. Locate an area that has much precipitation but little vegetation.
 - f. Find an area where little precipitation has occurred, yet there is still vegetation.

Part 3: Investigate Relationships & Patterns

Divide up the class into six groups and assign each group with a continent for them to investigate.

6. Students investigate an area that has high level of precipitation.
 - g. What is the vegetation level?
 - h. What is the latitude/longitude?
 - i. What is the NDVI value?
 - j. How may these areas be related?
 - k. What additional datasets would you like to review?
7. Students investigate an area that has low level of precipitation.
 - a. What is the level of vegetation?
 - b. What is the latitude/longitude?
 - c. What is the NDVI value?
 - d. How may these areas be related?
 - e. What additional datasets would you like to review?
8. State a claim based on evidence.

The claim that when _____ (occurs), then _____ (happens).



Name: _____

Date: _____

Using Precipitation and Vegetation to Study Climate Zones Student Datasheet

Part 1: Observe Precipitation & Vegetation Visualizations

1. What is the difference between **Climate** and **Weather**?
2. What are the two science variables you are reviewing today?
 - a.
 - b.
3. 1st map visualization:
 - a. What is the name of the map visualization?
 - b. Review the legend of the image:
 - What does the dark brown (or white on grayscale) represent?
 - What does the dark blue (or black on grayscale) represent?
 - c. What month and year does this visualization show?
 - d. Look at the Pacific Ocean. Notice the unique pattern of a streak of precipitation in a zone of dryness. Why is that?
 - e. Find two locations where there is high precipitation values but little vegetation and where there is little precipitation but high vegetation. Look at different data sets in order to discover outlier areas.
4. 2nd map visualization:
 - a. What is the name of the map visualization?
 - b. Review the legend of the image:
 - i. What does the bright green (or dark gray on grayscale) represent?
 - ii. What does the white (light gray on grayscale) represent?
 - iii. What month does this represent?

Part 2: Compare visualizations

5. Compare the two visualizations and critique these.
 - a. Describe one similarity:



- b. Describe one difference:
- c. Find a case study where there is high rates of precipitation but little vegetation.
- d. Find a case study of an area where not a lot of precipitation has occurred, yet there is still vegetation.

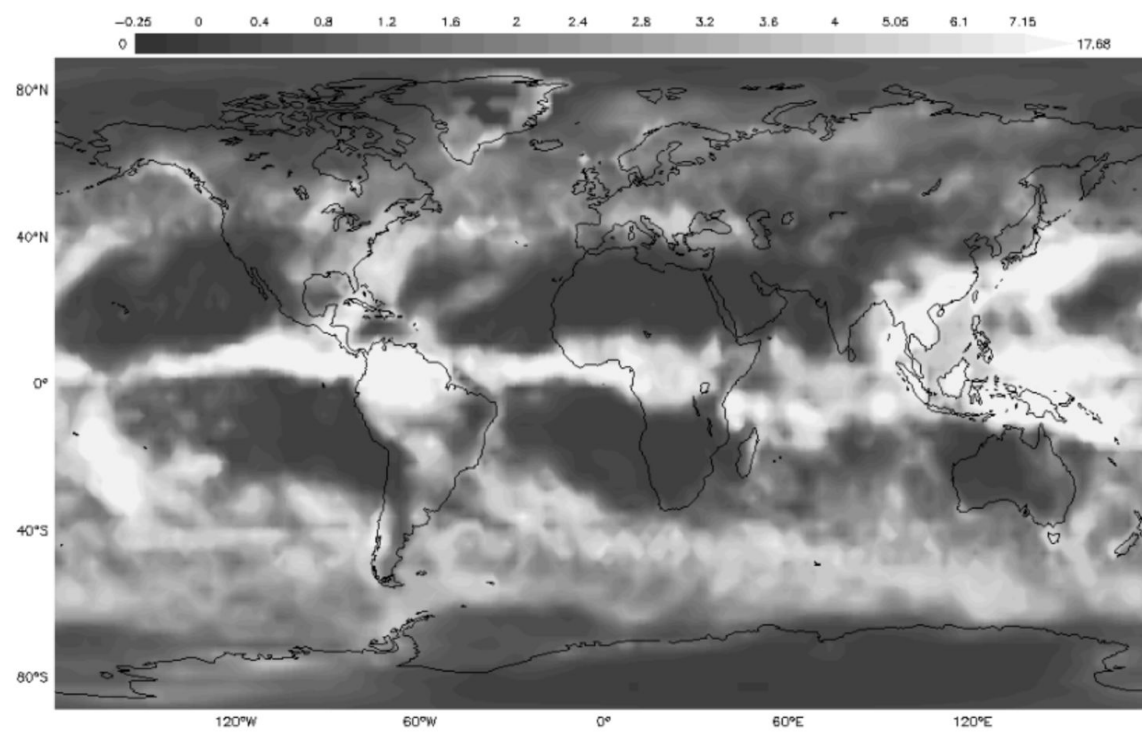
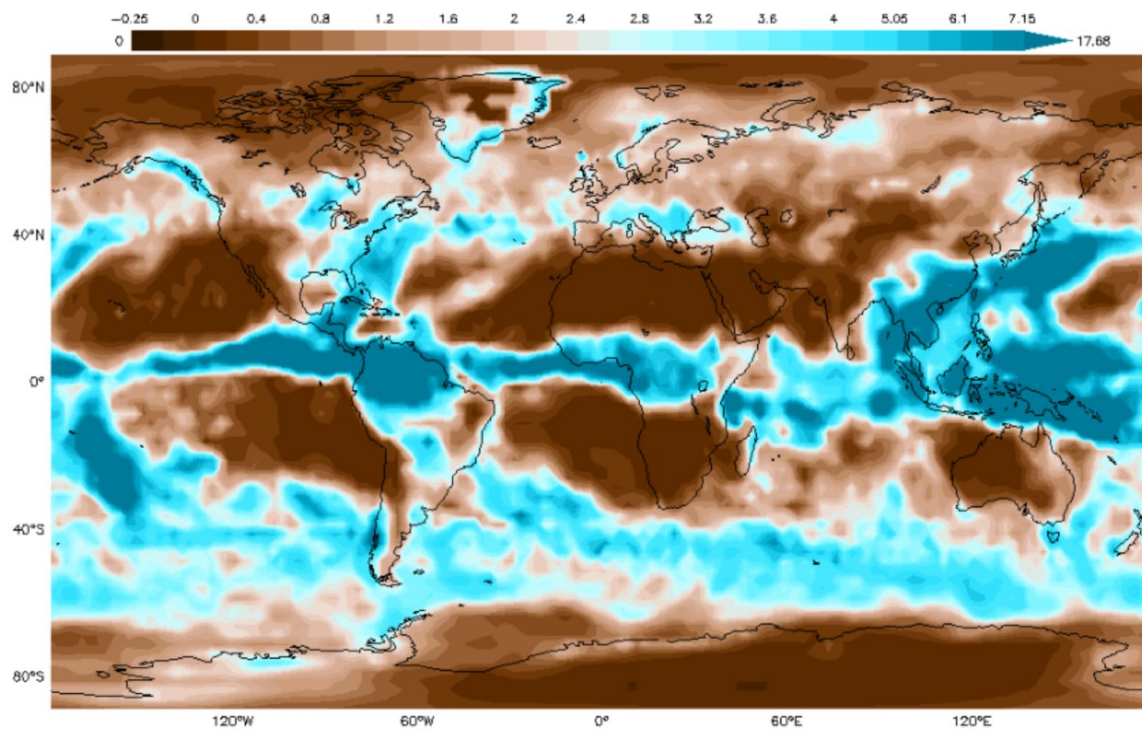
Part 3: Investigate Relationships & Patterns

Divide up the class into six groups and assign each group with a continent for them to investigate.

- 6. Students investigate an area that has high level of precipitation.
 - a. What is the vegetation level?
 - b. What is the latitude/longitude?
 - c. What is the NDVI value?
 - d. How may these areas be related?
 - e. What additional datasets would you like to review?
- 7. Students investigate an area that has low level of precipitation.
 - f. What is the level of vegetation?
 - g. What is the latitude/longitude?
 - h. What is the NDVI value?
 - i. How may these areas be related?
 - j. What additional datasets would you like to review?
- 8. State a claim based on evidence.
 - k. The claim that when _____ (occurs), then _____ (happens).

Monthly Precipitation (GPCP), MAY 2012

STUDENT PAGE



Monthly Normalized Difference Vegetation Index

STUDENT PAGE

